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TMA (TRIMETHYL-ALUMINUM) WINDS PROGRAM

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GCA Corporation

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ABSTRACT

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SECTION I
INTRODUCTION

The general objective of this contract was the measurement of thermospheric winds during a coordinated program involving several sounding rocket launches and associated ground based observations at Poker Flat, Alaska. The wind measurements were to be obtained from ground based photographic observations of a trail of trimethyl-aluminum (TMA) released from a sounding rocket. The specific requirements were to modify the design of a standard TMA payload so that it could be efficiently used on a Paiute-Tomahawk rocket system, construct the payload, and provide field services to assist in the rocket launching and in the photography of the release. These requirements have all been completed prior and subsequently to the successful launching of the sounding rocket at about local midnight on March 26, 1973.

SECTION II

TMA PAYLOAD

TMA interacts with the atmosphere to produce a chemiluminescent glow which allows wind observations at night over the height range 90 to about 160 km. A standard payload to produce a trail from a smaller rocket system, (Nike-Apache) has been used successfully for a number of years. Minor modifications to this design which allow its efficient use with the Paiute-Tomahawk system are much less expensive than a new design and eliminate the necessity for extensive performance tests because of the successful past flight record of the unit. These units contain two completely independent actuator systems composed of a pre-set mechanical timer, batteries, pressure switch, arming plugs, and electrically actuated valves. Payloads have been delivered on previous contracts and were described in detail in a report entitled "Alkali Vapor Payload Assembly and Checkout Manual" GCA-TM-69-1, Contract No. F19650-69-C-0509.

The minor modifications required to adjust the standard unit for utilization on a Tomahawk vehicle are fitting the TMA cannister and instrument rack into a 9 inch O.D. cylinder with the proper forward and rear interface connections. The connections are standard designs with complete drawings and specifications. The sections were machined according to these drawings and then checked before shipment by actual fitting to the other rocket sections.

The use of the standard units also allowed the use of the standard procedures for preflight checks, final assembly, and pad checks.

SECTION III PHOTOGRAPHIC SITES

The Poker Flat rocket range has utilized several surrounding locations as observational sites. The locations of some of them are shown in Figure 1. Four of these locations were chosen as primary triangulation sites for the TMA trail observations. The geographical coordinates of the chosen sites are given in Table I.

TABLE I LOCATION OF PHOTOGRAPHIC SITES

<u>Name</u>	<u>Latitude North</u>	<u>Longitude West</u>
Stevens Village	66° 0.53'	149° 5.63'
Fort Yukon	66° 33.0'	145° 13.0'
Ester Dome	64° 53.0'	148° 3.2'
Big Delta	63° 56.4'	145° 47.98

All of these sites had heated enclosures for the personnel and equipment and clear plexiglass bubbles through which the vapor trail could be photographed. Three of the sites had reliable phone line communications. A single side band radio link was used at Stevens Village with an emergency arrangement for one-way communications through the local commercial radio station in case of poor transmission conditions during magnetic storms. The emergency arrangement was employed during the firing.

All of the sites had two 70mm cameras with 3.3" lens which operated automatically from a synchronous timer. The operator turned the unit on at a precise time in order to insure simultaneity of photographs at all sites. In addition, Ester Dome, had two K-24 cameras with 7" and 20" lenses. Ft. Yukon and Stevens Village can be reached by air only, whereas Ester Dome and Big Delta are usually accessible by road.

GCA personnel aided in establishing the sites, furnished instruction on camera operation and procedures, and operated the cameras at

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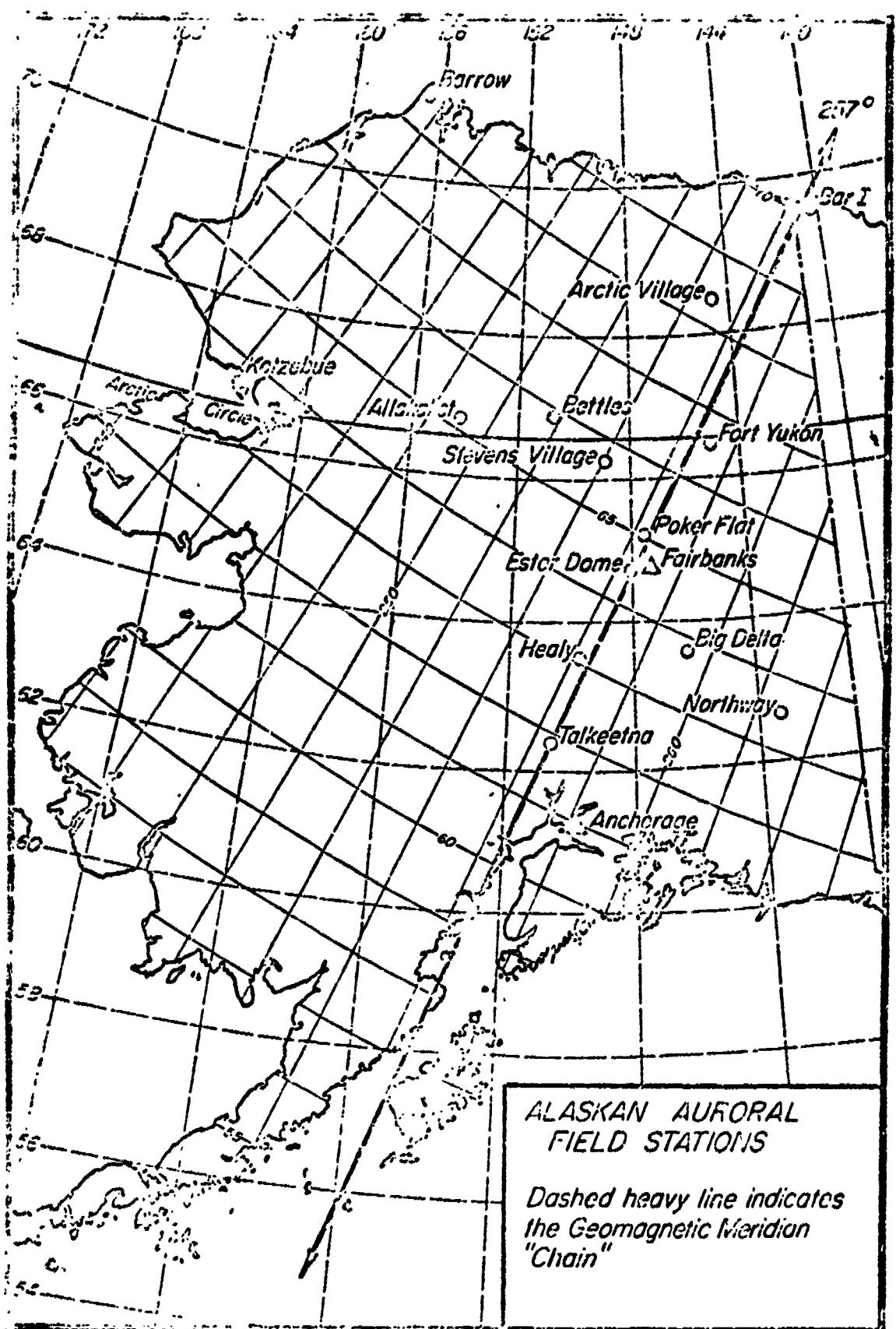


Figure 1. Field Site Locations in the Vicinity of the
Poker Flat Sounding Rocket Range.

the Ester Dome site. Camera operation and communication with all other sites were provided by the range.

SECTION IV

ROCKET LAUNCH AND OBSERVATIONS

All of the instrumentation (rocket payload and ground based cameras) was packed and delivered to AFCRL for shipment to Alaska via an Air Force cargo plane. The equipment arrived on schedule and in good condition. The payload was prepared and photographic sites were activated, also on schedule. The launch occurred at 0940 U.T. on 27 March 1973. The rocket flight path was as predicted except for an unexplained azimuth shift of about 30 degrees. The timely ejection of TMA was observed from the launch site. The countdown was advanced quickly, near to the scheduled firing and the launch occurred earlier than originally scheduled.

The photographic site at Big Delta did not receive notice of the rocket firing schedule change and did not operate the cameras for observation of the TMA trail. This situation was unfortunate because Big Delta had been reporting good sky conditions for the observations. Stevens Village and Ft. Yukon were reporting practically complete cloud cover which was verified in their photographs. No traces of the TMA trail could be found on the Stevens Village film. A few frames from Ft. Yukon recorded some portion of the trail being ejected but no usable data were obtained. The sky was clear in the viewing direction at Ester Dome and good data were obtained. The TMA produced an initially bright trail over the predicted height range, but persisted for a relatively short time. This effect has been noted in previous trails and is not entirely understood. However, the trail was photographable over a period sufficient for an accurate wind determination if observing sites had been clear. In Figure 2, the trail is about 2 minutes old.

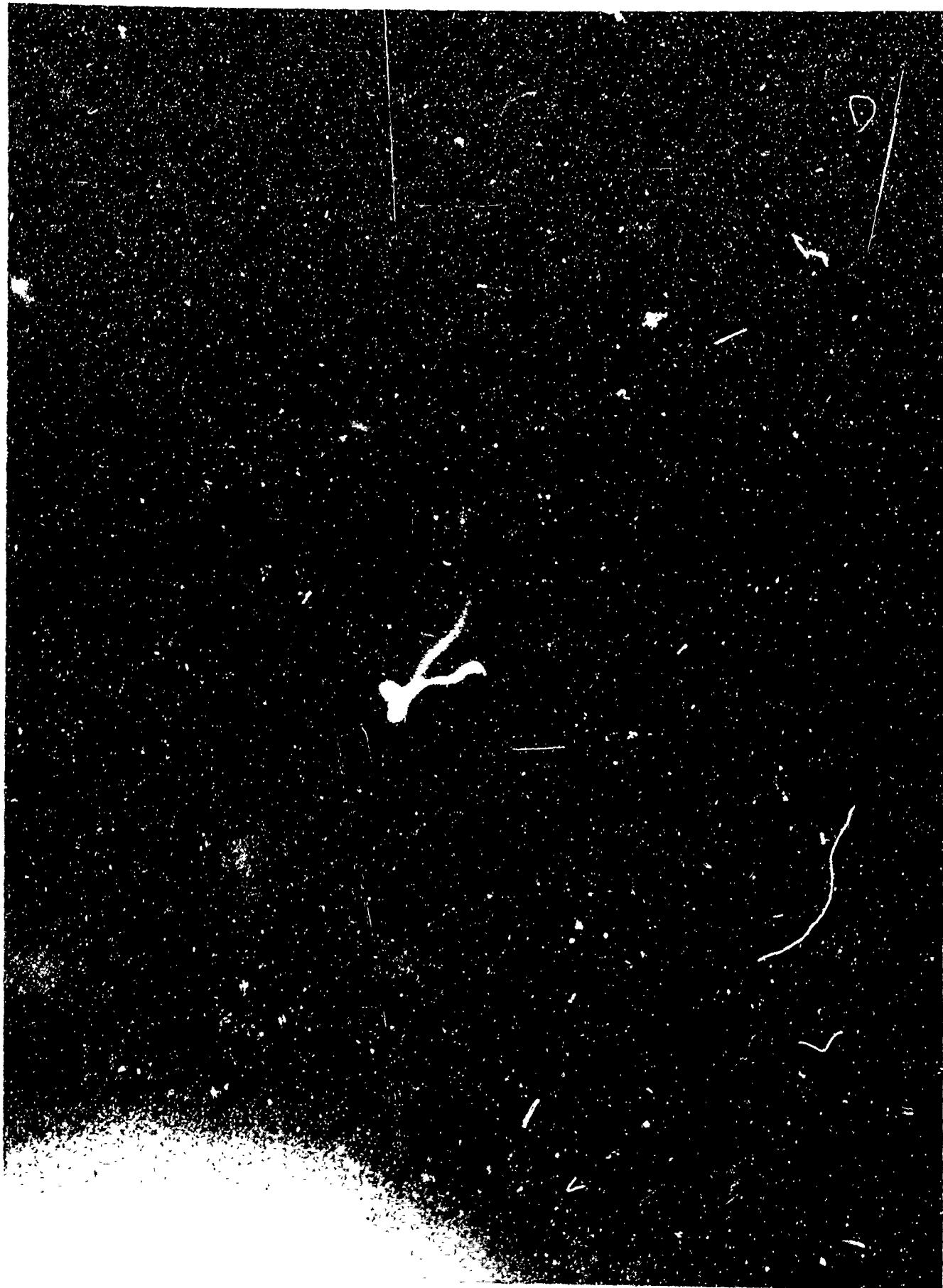


Figure 1. Photograph of the 226A seal as observed from
Litter Dome at 14:00 hrs.

SECTION V
CONCLUSIONS AND RECOMMENDATIONS

The payload and photographic sites appear to be satisfactory for continuing operation with the incorporation of some improvements in communications and coordination between sites.

The usual processing of photographic data to obtain winds is not possible because observations were obtained from only one site. However, it is possible to deduce a less complete and less accurate wind profile from the one-site data. This has been done on previous occasions⁽¹⁾, and it is recommended in this case because most of the other measurements in the program were successful.

Finally, it is recommended that the use of an aircraft as the primary observing platform be considered. It has been demonstrated⁽²⁾ that the uses of this technique will overcome the problems of remote site operation and weather which were encountered in this program. In addition, winds may be measured in the daytime with the aircraft method.

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